

Claims in 07/996,817 as of termination of interference on 2/25/02

32. A method of monitoring thickness change in a layer undergoing rotation of (a) a semiconductor device or (b) a patterned layer intermediate, wherein the layer is composed of a material selected from the group consisting of an insulating material, a semi-conducting material, a conducting material, and combinations thereof, and the semiconductor device or patterned layer intermediate is undergoing a process selected from the group consisting of chemical mechanical polishing, resist development, post-exposure bake, spin coating, and plasma etching, said method comprising the steps of

illuminating a section of the rotating layer through the back side of the semiconductor device or patterned layer intermediate with light of a wavelength between about 1,000 nm and about 11,000 nm,

passing a reflected light signal returning from the illuminated section through a rotating coupler,

measuring the reflected light signal, and

determining thickness change based on the measured light signal.

33. The method as claimed in claim 32, wherein the wavelength is between 1,000 nm and 11,000 nm.

34. A method for manufacturing semiconductor devices and silicon-on-insulator wafers comprising the steps of

polishing a substrate by rotating the substrate and contacting one side of the substrate with a polishing pad, wherein the substrate is composed of a material selected from the group consisting of an insulating material, a conducting material, a semiconductor material, and combinations thereof,

illuminating a section of a film on the substrate while the substrate rotates and undergoes polishing by passing light from the side of the substrate not being polished through the substrate to the section of the film on the substrate undergoing polishing, wherein the light passing through the substrate has a wavelength between about 1,000 nm and about 11,000 nm,

optically receiving a light signal reflected from the illuminated section with an optical receiver which rotates with the substrate, and

passing the reflected light signal through a rotation decoupler connected to a photodetector, which does not rotate with the substrate, and

calculating thickness change with an analyzer connected to the photodetector based on interferometry.

35. The method of claim 34, wherein the illuminated section of the film contains a pattern.

36. The method of claim 34, wherein the wavelength is between 1,000 nm and 11,000 nm.

37. A method of monitoring thickness change in a film on a substrate undergoing rotation comprising the steps of

illuminating a section of the film through the back side or from the front side of the substrate,

measuring a light signal returning from the illuminated section with at least one photodetector undergoing the same rotation as the substrate,

converting the light signal to an electrical signal,

passing the electrical signal through an electrical slip ring and determining thickness change based on the electrical signal.

38. The method of claim 37, wherein the film is undergoing a process selected from the group consisting of chemical mechanical polishing, chemical vapor deposition, resist development, post-exposure bake, spin coating, and plasma etching.

39. The method of claim 37, wherein the illuminated section of the film is illuminated by light having a wavelength between about 1,000 and about 11,000 nanometers.

40. The method of claim 37, wherein the illuminated section of the film is illuminated by light having a wavelength between 1,000 and 11,000 nanometers.

41. A method according to claim 37, wherein the illuminated section of the film contains a pattern.

42. A method of monitoring thickness change in a film on a front side of a substrate undergoing rotation comprising the steps of
illuminating a section of the film from the front side of the substrate,
measuring a reflected light signal returning from the illuminated section with at least one photodetector undergoing the same rotation as the substrate,
passing the reflected light signal through a rotating coupler which connects to an analyzer and monitoring thickness change based on the measured light signal.

43. The method of claim 42, wherein the film is undergoing a process selected from the group consisting of chemical mechanical polishing, chemical vapor deposition, resist development, post-exposure bake, spin coating, and plasma etching.

44. The method of claim 42, wherein the illuminated section of the film is illuminated by light having a wavelength between about 200 and about 11,000 nanometers.

45. The method of claim 42, wherein the illuminated section of the film is illuminated by light having a wavelength between 200 and 11,000 nanometers.

46. The method of claim 42, wherein the illuminated section of the film contains a pattern.

47. A method for producing a semiconductor device or a patterned layer intermediate, which comprises the steps of:

polishing at least one layer on one side of the semiconductor device or the patterned layer intermediate, wherein the layer is composed of a material selected from the group consisting of an insulating material, a semi-conducting material, a conducting material, and combinations thereof,

illuminating said at least one layer with light of a wavelength between about 200 nm and about 11,000 nm during the polishing step by projecting the light through a rotation decoupler to said at least one layer,

measuring the intensity of the light reflected by said at least one layer,

calculating the thickness of said at least one layer based on the intensity of the reflected light, and

terminating the polishing step when the layer thickness reaches a predetermined value.

48. The method as claimed in claim 47, wherein the thickness is calculated based on interferometry.

49. The method of claim 47, wherein the wavelength is between 200 and 11,000 nanometers.

50. A method for manufacturing semiconductor devices and silicon-on-insulator wafers from a substrate comprising the steps of

polishing the substrate by rotating the substrate and contacting one side of the substrate with a polishing pad, wherein the substrate is composed of a material selected from the group consisting of an insulating material, a conducting material, a semiconductor material, and combinations thereof,

illuminating a section of a film on the substrate while the substrate rotates and undergoes polishing by passing light from a side of the substrate not being polished through the substrate to the section of the film on the substrate undergoing polishing, wherein the light passing through the substrate has a wavelength between about 1,000 nm and about 11,000 nm,

measuring a light signal reflected from the illuminated section with a photodetector which rotates with the substrate, and

passing the reflected light signal through a rotation decoupler connected to an analyzer, and

calculating thickness change with the analyzer based on interferometry.

51. The method of claim 50, wherein the wavelength is between 1,000 and 11,000 nanometers.

52. A method for manufacturing a semiconductor device, a patterned intermediate, or a silicon-on-insulator wafer from a substrate comprising the steps of

polishing at least one film on a front side of the substrate by rotation against an abrasive surface, wherein the substrate comprises at least one layer which is composed of a silicon material and wherein said at least one film is composed of a material selected from the group consisting of silicon oxide, silicon nitride, and poly-silicon,

illuminating said at least one film by shining light from a back side of the substrate through the substrate to said at least one film causing light to reflect off of said at least one film, wherein the illuminating light has at least one wavelength of energy near or below the bandgap energy of the silicon material of the substrate,

passing the reflected light through a rotation decoupler,

analyzing thickness of said at least one film based on interferometry and based on the reflected light, and

stopping polishing when the film thickness reaches a predetermined value.

53. The method of claim 52, wherein the rotation decoupler is a fiber-optic rotating decoupler.

54. The method of claim 52, wherein the rotation decoupler is an electrical slip ring.

59. A method for producing a semiconductor device or a patterned layer intermediate, which comprises the steps of:

Polishing at least one layer on one side of the semiconductor device or patterned layer intermediate, wherein the layer is composed of a material selected from the group consisting of an insulating material, a semi-conducting material, a conducting material, and combinations thereof,

illuminating the side of the semiconductor device or patterned layer intermediate not being polished with light of a wavelength between about 1,000 nm and about 11,000

nm during the polishing step so that the light passes through the semiconductor device or the patterned layer intermediate and reaches said at least one layer,

measuring the intensity of the light reflected by said at least one layer,
calculating the thickness of said at least one layer based on the intensity of the reflected light, and

terminating the polishing step when the layer thickness reaches a predetermined value.

60. The method of claim 59, wherein the thickness is calculated based on interferometry.

61. The method of claim 59, wherein the wavelength is between 1,000 nm and 11,000 nm.

62. A method for manufacturing a semiconductor device or a patterned intermediate or a silicon-on-insulator wafer from a substrate comprising the steps of
chemically mechanically polishing at least one film on a front side of the substrate, wherein the substrate comprises at least one layer which is composed of a silicon material and wherein said at least one film is composed of a material selected from the group consisting of silicon oxide, silicon nitride, and poly-silicon,

illuminating said at least one film by shining light from a back side of the substrate through the substrate to said at least one film causing light to reflect off of said at least one film, wherein the illuminating light has at least one wavelength of energy near or below the bandgap energy of the silicon material of the substrate,

analyzing thickness of said at least one film based on interferometry and based on the reflected light, and

stopping polishing when the film thickness reaches a predetermined value.

68. The method of claim 64 wherein said exposed layer surface is irregular with raised and depressed areas thereacross, the material removing substance applied to the exposed layer surface is a slurry of abrasive particles, and material is removed from the layer exposed surface by urging the slurry against the layer exposed surface with a planar surface and providing relative motion between the layer exposed surface and the planar surface.

69. The method of claim 68 which additionally comprises detecting a characteristic of the varying intensity of the detected second beam component which indicates when the exposed layer surface has become planarized, and, in response to detecting said characteristic, altering the material removal process on said layer exposed surface.

70. The method of either of claims 68 or 69 wherein said relative motion is provided by rotating the substrate and layer with respect to the planar surface.

71. The method of any one of claims 64, 68 or 69 wherein the layer is a dielectric material layer.

82. The process according to either claim 77 or 81 wherein the placing step includes placing the first side of the substrate in contact with an abrasive medium, and the process further comprises the step of providing relative motion between the first side of the substrate and said abrasive medium.

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nm during the polishing step so that the light passes through the semiconductor device or the patterned layer intermediate and reaches said at least one layer,
measuring the intensity of the light reflected by said at least one layer,
calculating the thickness of said at least one layer based on the intensity of the reflected light, and
terminating the polishing step when the layer thickness reaches a predetermined value.

62. (Amended) A method for manufacturing a semiconductor device or a patterned intermediate or a silicon-on-insulator wafer from a substrate comprising the steps of

chemically mechanically polishing at least one film on a front side of the substrate, wherein the substrate comprises at least one layer which is composed of a silicon material and wherein said at least one film is composed of a material selected from the group consisting of silicon oxide, silicon nitride, and poly-silicon,

illuminating said at least one film by shining light from a back side of the substrate through the substrate to said at least one film causing light to reflect off of said at least one film, wherein the illuminating light has at least one wavelength of energy near or below the bandgap energy of the silicon material of the substrate,

analyzing thickness of said at least one film based on interferometry and based on the reflected light; and

stopping polishing when the film thickness reaches a predetermined value.

68. (Amended) A method of removing at least a portion of a layer that is carried on a first side of a substrate, comprising:

applying a material removing substance to an exposed surface of said layer but not to a second side of the substrate opposite said first side, said substance being characterized by modifying electromagnetic radiation incident thereon, whereby material is removed from said layer exposed surface but not from the second side of the substrate,

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directing a first beam of electromagnetic radiation against said second side of the substrate to said layer through said substrate, said first beam of electromagnetic radiation including a wavelength band to which each of said substrate and said layer is substantially transparent,

receiving and detecting a second beam of electromagnetic radiation within said wavelength band that is a portion of said first beam that exits the second substrate side after reflection at boundary surfaces of said layer and said substrate, and

concurrently with material being removed from the exposed surface of the layer, monitoring a varying intensity of a component of the detected second beam which results from an interference between portions of the first beam reflected

from said exposed surface and an underlying boundary surface,

wherein said exposed layer surface is irregular with raised and depressed areas thereacross, the material removing substance applied to the exposed layer surface is a slurry of abrasive particles, and material is removed from the layer exposed surface by urging the slurry against the layer exposed surface with a planar surface and providing relative motion between the layer exposed surface and the planar surface.

82. (Amended) A process of removing material carried by a first side of a substrate that is held for processing, comprising the steps of:

placing the first side of the substrate in contact with a material removing substance,

directing through a second side of the substrate and against said material an electromagnetic radiation beam having a wavelength band to which said substrate and said material are substantially transparent, and

detecting a particular characteristic of the state of the material removal process from a component of the radiation beam reflected from said material through said second substrate side, said component having an intensity which varies over time from interference between portions of the radiation beam reflected from different boundary surfaces as said material is being removed,

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wherein the material being removed is from a layer of said material that is different from the substrate, and wherein said boundary surfaces include surfaces of said layer,

wherein the placing step includes placing the first side of the substrate in contact with an abrasive medium, and the process further comprises the step of providing relative motion between the first side of the substrate and said abrasive medium.--

Please add claim 87.

-- 87. (New) A process of removing material carried by a first side of a substrate that is held for processing, comprising the steps of:

placing the first side of the substrate in contact with a material removing substance, directing through a second side of the substrate and against said material an electromagnetic radiation beam having a wavelength band to which said substrate and said material are substantially transparent, and

detecting a particular characteristic of the state of the material removal process from a component of the radiation beam reflected from said material through said second substrate side, said component having an intensity which varies over time from interference between portions of the radiation beam reflected from different boundary surfaces as said material is being removed,

wherein the material being removed is from the substrate itself,

wherein the placing step includes placing the first side of the substrate in contact with an abrasive medium, and the process further comprises the step of providing relative motion between the first side of the substrate and said abrasive medium. --